REMARKS

Applicants thank Examiner Green and SPE David Simmons for the courtesy of an Office Interview conducted on 11 September 2002. During the interview, Applicants discussed the invention, discussed the teachings of the Kahlbaugh et al. reference, discussed amendments bringing the claims into allowability and other prior art matters.

Formal drawings are now under preparation and will be filed in due course, well prior to allowance.

The specification has been amended on page 26, lines 16-17 to indicate the missing serial number (09/871,583 filed on May 31, 2001). This serial number does not constitute new matter.

The claims have been amended to recite specific diameters for the film and substrate. Support for the amendments are found at page 23, line 21 (as amended), page 6, line 27 and claim 7, page 4, lines 14-15, page 3, lines 18-21 and in the claims as filed.

Claim 17 has been amended for consistency.

Claim 21 has been cancelled as redundant.

The Examiner has rejected claims 4, 14, and 28 under 35 U.S.C. § 112 arguing that certain aspects of the claimed subject matter are not reflected in the specification. The specification has been amended in the paragraph beginning on page 13, line 28, at page 14, line 8, to recite the recitations of the claims that do not appear expressly in the specification. The specification has been amended to recite an abstract for ASTM-1215-89, an efficiency test method for filter structures cited in the original claims. This test was in existence prior to the filing date of the patent, was known and used by the inventors and does not constitute new matter in this application.

Applicants have enclosed with this response a copy of the Test Method ASTM F1215-89, Standard Test Method for Determining the Initial Efficiency of a Flatsheet Filter Medium in an Airflow Using Latex Spheres.

The Examiner has rejected claims 10 and 35 under 35 U.S.C. § 112 arguing that certain aspects of the claimed subject matter are not reflected in the specification. The specification has been amended in the paragraph beginning on page 13, line 28, at page 14, line 8, to include the recitations from the claims that do not appear expressly in the specification. These amendments are based on the claims as originally filed and do not constitute new matter. Claims 10 and 35 have been amended a suggested by the Examiner.

The Examiner has rejected claims 1, 4, 11, 14, 25 and 28 under 35 U.S.C. § 112 arguing that the term "sheet-like" renders the claims indefinite. The claims have been amended to remove the term.

The term "the filter structure" in claim 11 at line 5 has support in claim 11 at line 3.

Claims 26 and 30-34 have been amended to clarify the nature and position of the layers.

The Examiner has rejected claims 1-3, 5-8 and 10, 11-13, 15-18, 20-24, 25-27, 29-33 and 35 under 35 U.S.C. § 103 over Kahlbaugh et al., U.S. Patent No. 5,672,399. Applicants respectfully traverse.

The disclosure in Kahlbaugh et al. is to a very different structure than claimed. In Kahlbaugh et al., the primary concept is to add additional layers of fine fiber to a non-filter type support that is not a filter substrate until the fine fiber reaches sufficient filtration properties to affect sufficient filtration for the engineer's purposes. In other words, Kahlbaugh et al. disclose multiple layers of fine fiber separated by a separation layer that has no significant filter properties. The concept of Kahlbaugh et al. is to add a sufficient number of fine fiber layers to obtain filtration properties from the fine fiber layers. The separation layers are simply to provide a spacing gap between fine fiber layers without producing any significant filtration properties.

As disclosed in the specification, Applicants' invention relies on the cooperation between a filter substrate material and a layer of fine fiber positioned on either side of the filtration substrate to obtain filtration and long useful life. The substrate has its own filtration properties. The cooperation between these three layers provides substantially improved filtration properties. This cooperation in filtering layers is not taught in Kahlbaugh et al. Applicants have demonstrated that, using a single substrate layer and two or more fine fiber layers, significant filtration properties can be obtained, while Kahlbaugh et al. suggest that to maximize filtration properties, additional layers of fine fiber should be added to the filtration structure.

Applicants have amended the claims to further define the nature of the filter substrate in terms of efficiency and permeability, to further define the nature of the fine fiber layer in terms of fiber size, pore size, the overall efficiency of the structure and the nature of the structure having a single substrate layer with at least two fine fiber layers. Applicants assert that these amendments establish a non-obvious difference between the Kahlbaugh et al. structure, any secondary reference and the claimed invention and place the claims in condition for allowance.

In the following discussion, Applicants have combined certain rejections if based on identical references and substantially the same arguments.

The Examiner has rejected claims 4, 9, 14, 19, 28 and 34 under a combination of Kahlbaugh et al., U.S. Patent No. 5,672,399 and Sekiya et al., U.S. Patent No. 5,633,746. Applicants respectfully traverse the rejection. First, Applicants assert that the Sekiya et al. reference, relating to disc recording media, adds nothing to the Kahlbaugh et al. reference. The Sekiya et al. reference, while it teaches a polycarbonate material, teaches nothing about fiber, forming fine fiber or filtration properties. As a result, there is simply no reason why one of ordinary skill in the art would combine Sekiya et al. and Kahlbaugh et al. for any purpose. Further, the Sekiya et al. reference does not suggest, in any way, that polycarbonate material should be used in fine fiber material. Further, the amendments to the independent claims of the application define over Kahlbaugh et al., making this rejection over Kahlbaugh et al. and Sekiya et al. moot.

The Examiner has made additionally rejections under 35 U.S.C. § 103 based on Kahlbaugh et al. over claims 11-13, 15-18 and 20-24 (Examiner's paragraph 17), claims 5-21, 29-33 and 35 (Examiner's paragraph 19) and over a combination of Kahlbaugh et al. and Sekiya et al. of claims 14 and 19 (Examiner's paragraph 18) and claims 28 and 34 (Examiner's paragraph 20). Applicants have amended independent claims 11 and 25 similarly to claim 1. The claim amendments in this paper clearly distinguish any aspect of Kahlbaugh et al. or Sekiya et al. that the Examiner may rely on in the 35 U.S.C. § 103(a) rejection.

Applicants believe that these claim amendments are consistent with discussions during the office interview leading to the Examiner's indication that such claim amendments place the claims in condition for allowance.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

Respectfully submitted,

Date

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification

Paragraph beginning on page 3, line 22 should be amended as follows.

-- We believe one mechanism by which the fine fiber layer obtains a substantially increased pressure drop results from the "filming over" phenomenon. As filtered particulate materials interact with the fine fiber and become trapped in the fine fiber mesh or web, the particulates, particularly if they are low volatility liquids, can form a liquid film completely filling an opening pore or space in the fine fiber mesh. As these areas in the mesh are filled with fluid, the pressure across the filter rapidly increases. The filming over property can also result from interaction between particulates and the fine fiber but simply results from the filling of the unoccupied space within the fiber web causing pressure increase. Having a layer on the downstream side that is greater in efficiency than the upstream side, by more than 3% preferably 5% or more, increases overall efficiency but does not reduce lifetime because the upstream layer and the substrate remove entrained particulate and reduce the tendency of the downstream fine fiber to plugging. One measure of defining lifetime can indicate that the filter structure has completed its lifetime when the pressure drop across the filter increases to about 3 inches of water or more at a test condition of 10 ft/min of flowing medium.--

Paragraph beginning on page 6, line 12 should be amended as follows.

-- The conventional filter construction involves the application of fine fiber to the substrate in a single layer in a substantially complete coverage of the media. Sufficient fine fiber is typically used in the fine fiber layer such that the resulting media construction has an initial efficiency of greater than 50%, preferably greater than 80% (on an average basis) with no individual construction having an efficiency less than 30% (the efficiency test is ASTM 1215 89 using monodisperse 0.78 micron polystyrene latex particulate at 20 ft-min^{-1}). This efficiency test generally measures the effectiveness of the test substrate to remove from a moving air stream the recited particulate that is moving at the recited rate. The efficiency is expressed as a percent relating to the percent of the total particles tested that is removed by the filter. This test method measures the initial efficiency of a flatsheet filter medium by sampling representative volumes of

the upstream and downstream latex aerosol concentrations in a controlled airflow chamber. Filtered and dried air is passed through an atomizer to produce an aerosol containing suspended latex spheres. This aerosol is then passed through a charge neutralizer. The aerosol is then mixed and diluted with additional preconditioned air to produce a stable, neutralized, and dried aerosol of latex spheres to be used in the efficiency test. These test techniques can be used in filter medium testing for aerosol efficiency performance at discrete aerosol particle sizes for both manufacturers and users. It establishes a basis of efficiency comparison of one filter medium to another. For conventional filters, efficiencies less than about 30% on the average or for any particular filter is typically considered unacceptable since such a filter would pass a substantial proportion of the impinging particulate in the mobile fluid phase. Such an amount of particulate, in an engine application, in a gas turbine application or other such applications would pass substantially more particulate to the working parts of the mechanism such that substantial wear or failure of the mechanical device could result.--

Paragraph beginning on page 13, line 28 should be amended as follows.

--An important aspect of the invention is the utility of such microfiber or nanofiber materials formed into a filter structure. In such a structure, the fine fiber materials of the invention are formed on and adhered to a filter substrate. Natural fiber and synthetic fiber substrates, like spun bonded fabrics, non-woven fabrics of synthetic fiber and non-wovens made from the blends of cellulosics, synthetic and glass fibers, non-woven and woven glass fabrics, plastic screen like materials both extruded and hole punched, UF and MF membranes of organic polymers can be used. Sheet-like substrate or cellulosic non-woven web can then be formed into a filter structure that is placed in a fluid stream including an air stream or liquid stream for the purpose of removing suspended or entrained particulate from that stream. The shape and structure of the filter material is up to the design engineer. One important parameter of the filter elements after formation is its resistance to the effects of heat, humidity or both. An important aspect of the filter media of the invention is the ability of the filter media to survive contact with warm humid air. In contact with such hot humid air streams, the fine fiber should retain greater than 50% of the fiber unchanged for filtration purposes after being exposed to air having a temperature of 140°F and 100% relative humidity for 16 hours. One aspect of the filter media of the invention is a test of the ability of the filter media to survive immersion in warm water for a

significant period of time. The immersion test can provide valuable information regarding the ability of the fine fiber to survive hot humid conditions and to survive the cleaning of the filter element in aqueous solutions that can contain substantial proportions of strong cleaning surfactants and strong alkalinity materials. Preferably, the fine fiber materials of the invention can survive immersion in hot water while retaining at least 50% of the fine fiber formed on the surface of the substrate as an active filter component. Retention of at least 50% of the fine fiber can maintain substantial fiber efficiency without loss of filtration capacity or increased back pressure. Most preferably retaining at least 75%. The thickness of the typical fine fiber filtration layer ranges from about 0.001 to 5 microns, preferably 0.01 to 3 microns with a fine fiber basis weight ranging from about 0.01 to 240 micrograms-cm^{-2}. The fine fiber layers formed on the substrate in the filters of the invention should be substantially uniform in both filtering performance and fiber location. By substantial uniformity, we mean that the fiber has sufficient coverage of the substrate to have at least some measurable filtration efficiency throughout the covered substrate. Adequate filtration can occur with wide variation in fiber add-on. Accordingly, the fine fiber layers can vary in fiber coverage, basis weight, layer thickness or other measurement of fiber add-on and still remain well within the bounds of the invention. Even a relatively small add-on of fine fiber can add efficiency to the overall filter structure.--

Paragraph beginning on page 23, line 18 should be amended as follows.

--In preferred arrangements, the first layer of permeable coarse fibrous material comprises a material which, if evaluated separately from a remainder of the construction by the Frazier permeability test, would exhibit a permeability of at least 1 meter(s)/min, and typically and preferably about 2-900 meters/min (about 0.03-15 m-sec^{-1}). Herein when reference is made to efficiency, unless otherwise specified, reference is meant to efficiency when measured according to ASTM-1215-89, with 0.78μ monodisperse polystyrene spherical particles, at 20 fpm (6.1 meters/min) as described herein.--

Paragraph beginning on page 26, line 10 should be amended as follows.

--Example of usable filter constructions are described in U.S. Pat. No. 5,820,646, which patent is incorporated by reference herein. In another example embodiment the fluted construction (not shown) includes tapered flutes. By "tapered," it is meant that the flutes enlarge along their length such that the downstream opening of the flutes is larger than the upstream opening. Such filter constructions are described in U.S. Patent Application Serial No. 08/639,220, herein incorporated by reference in its entirety. Details about fine fiber and its materials and manufacture is disclosed in U.S. Patent Application Serial No. 09/871,583 [____________], herein incorporated by reference.--

In the Claims

Please amend the claims as follows:

1. (AMENDED) A fine fiber filter media comprising a single layer of [sheet-like] filter substrate, the substrate [sheet] having a first surface and a second surface, the substrate having a permeability of about 0.03 to 15 m-sec^{-1} and an efficiency greater than 5%, the first surface and the second surface each comprising a layer of fine fiber having a diameter of about 0.001 to 0.5 microns, the layer of fine fiber having a thickness of less than 5 microns, the layer of fine fiber formed in an amount effective to obtain a pore size of about 0.0001 to 5 microns, an overall efficiency under ASTM-1215-89 with monodisperse 0.78 micron polystyrene latex particles at 20 ft/min velocity of [less than] about 50% to 90% in any one layer and to obtain an efficiency of greater than 90% in the [both] layers combined.

10. (AMENDED) The filter media of claim 1 wherein the fine fiber forming an interlocking mesh of fiber having on the average a pore size between fibers in the web of less than about 3 microns; wherein the [substrate] filter media has an efficiency greater than the efficiency of a single sided media and has a lifetime, defined as an increase in pressure drop over the filter of about 3 inches H_2O at test conditions of 10 ft/min.

11. (AMENDED) A method of removing a particulate from an air borne stream, the particulate comprising a liquid particulate, a solid particulate or mixtures thereof, the method comprises:

(a) placing a filter structure in an air stream; and

(b) directing the air stream through the filter structure while monitoring the useful life of the filter structure; said filter structure comprising a fine fiber filter media and single layer of a [sheet-like] filter substrate the substrate having a permeability of about 0.03 to 15 m-sec^{-1} and an efficiency of greater than 5%, the [sheet] substrate having a first surface and a second surface, the first surface and the second surface each comprising a layer of fine fiber having a diameter of about 0.001 to 0.5 microns, the layer of fine fiber having a thickness of less than 5 microns, the fine fiber layer formed in an amount effective to obtain a pore size of about 0.001 to 5 microns, an efficiency under ASTM-1215-89 with monodisperse 0.78 micron polystyrene latex particles at 20 ft/min velocity of [less than] about 50% to 90% in any one layer and to obtain an efficiency of greater than 90% in the [both] layers combined.

17. (AMENDED) The method of claim 11 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of about 40% to 85% and in both layers combined to obtain an overall efficiency of greater than 65% and the substrate has an efficiency of about 5 [20]% to about 80%.

25. (AMENDED) A filter structure comprising one layer of [or more sheet like] filter substrate and three or more layers of fine fiber, [each sheet like] the substrate layer having a first surface and a second surface, the substrate having a permeability of about 0.03 to 15 m-sec^{-1} and an efficiency of greater than 5%, the surfaces comprising three or more layers of the fine fiber on the substrate, each fine fiber layer comprising fine fiber having a diameter of about 0.01 to 0.5 micron, each fine fiber layer having a thickness of less than 5 microns, the fine fiber layer formed in the amount effective to obtain a pore size of about 0.0001 to 5 microns, an efficiency under ASTM-1215-89 with monodisperse 0.78 micron polystyrene latex particles at 20 ft/min velocity [of less than] of about 50% to 90% in any one layer and to obtain an overall efficiency of greater than 90% in the layers combined.

26. (AMENDED) The filter media of claim 25 wherein the efficiency [of a fine fiber layer on the first surface] of one fine fiber layer in the filter structure is different than the efficiency [of the fine fiber layer on the second surface] of any other fine fiber layer in the filter structure.

28. (AMENDED) The filter media of claim 25 wherein the [sheet-like] filter substrate has a thickness of about 0.01 to 3 millimeters, any surface comprising a layer of fine fiber having a diameter of about 0.01 to 0.5 microns the layer having a thickness of less than 3 microns, the fine fiber selected such that after test exposure for a test period of 16 hours to test conditions of 140°F air and a relative humidity of 100% retains greater than 50% of the fiber unchanged for filtration purposes.

30. (AMENDED) The filter media of claim 25 wherein [the] each fine fiber layer is formed in an amount effective[, in each layer,] to obtain an efficiency of less than 85% and in [both] all layers combined to obtain an overall efficiency of greater than 90%.

31. (AMENDED) The filter media of claim 25 wherein [the] each fine fiber layer is formed in an amount effective[, in each layer,] to obtain an efficiency of less than 80% and in [both] all layers combined to obtain an overall efficiency of greater than 85%.

32. (AMENDED) The filter media of claim 25 wherein [the] each fine fiber layer is formed in an amount effective[, in each layer,] to obtain an efficiency of about 40% to 85% and in [both] all layers combined to obtain an overall efficiency of greater than 65% and the substrate has an efficiency of about 5% to about 80%.

33. (AMENDED) The filter media of claim 25 wherein [the] each fine fiber layer is formed in an amount effective[, in each layer,] to obtain an efficiency of about 40% to 80% and in [both] all layers combined to obtain an overall efficiency of greater than 65% and the substrate has an efficiency of about 20% to about 80%.

34. (AMENDED) The filter media of claim 25 wherein [the] each fine fiber layer is formed in an amount effective[, in each layer,] to obtain an overall efficiency of less than 75% and in [both] all layers combined to obtain an efficiency of greater than 80%, and retains greater than 30% of the fiber unchanged for filtration purposes.

35. (AMENDED) The filter media of claim 25 wherein the fine fiber forming an interlocking mesh of fiber having on the average a pore size between fibers in the web of less than about 3 microns; wherein the [substrate] filter media has an efficiency greater than the efficiency of a single sided media and has a lifetime, defined as an increase in pressure drop over the filter of about 3 inches H_2O at test conditions of 10 ft/min.

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